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TROPICAL FORESTS: ARE CONSERVATION AND FORESTRY COMPATIBLE?

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ABSTRACT. The conservation potential of sustainable management of tropical forests has been insufficiently studied. The potential synergies of conservation and forestry are not only enormous, but absolutely necessary to the survival of unprotected tropical forests. Political, economic, industrial, social and ecological criteria must be integrated into sustainable tropical forestry. Some examples of tropical forest management are highlighted. Tropical forests outside of protected areas are doomed if we do not find sustainable uses for these globally important natural resources.

INTRODUCTION

Can forest management based on sustainable principles contribute to the survival of tropical forests? The purpose of this article is to offer an overview of tropical forest management from the perspective of conservation. This is not a review of tropical forest management experiences, but rather an essay on important issues, especially the extraordinary challenge of how to sustainably use production forests, as well as future needs and expectations. Particular emphasis is given to the key criteria for sustainable use of tropical forests (cf. Fearnside 1989). I focus on broad-leaved, species-rich tropical forests of Latin America, commonly known as tropical rain forests, moist tropical forests, humid tropical forests, *inter alia.* In the Holdridge life zone classification system—that is widely used in tropical America–the bioclimatic range covered here includes a tropical and subtropical latitudinal belts, and premontane, lower montane and montane altitudinal zones. Natural forests dominated by conifers (e.g., northern Meso-America and the Greater Antilles) are not considered here (see Hartshorn 1988).

Tropical forests are truly a global resource, whose loss we see on a daily basis. Many countries rich in tropical forests have made considerable efforts to create a national system of protected conservation areas. However, few of these countries exceed the IUCN recommendation of a minimum of 10% of the country in protected areas, and many countries have "paper parks" and reserves that are illegally exploited and inadequately protected. In fact, nearly all the forest-rich countries such of those sharing the Amazon Basin, Congo Basin, or mega-islands of the tropical Far East, have less than 5% of the national territory in conservation areas.

Tropical forests harbor the great majority of this planet's biodiversity (Wilson 1992). Tropical deforestation not only causes extinction of species, it also contributes to global climate change, watershed degradation, soil erosion, and loss of development opportunities for local peoples as well as nations. The sustainable use of tropical forests, especially in forest-rich countries, is fundamental to the survival of these forests, their canopies, their biodiversity, and their ecological services; tropical forests may be fundamental to a country's economic survival as well.

In contrast to the Asian and African tropics (cf. Baur 1968, Collins *et al.* 1991, Sayer *et al.* 1992), there is not a long tradition of industrial forest management and silviculture in tropical America. The few notable exceptions are where British and Dutch colonial forestry persisted well into this century, such as the Guianas and Trinidad. Early 19th century independence of most of Latin America preceded colonial interest in tropical silviculture; however, appreciation of premium quality hardwoods such as true mahoganies (*Swietenia mahogani* and *S. macrophylla,* Meliaceae) goes back centuries (Lamb 1966, Hartshorn 1992). Probably because it has the most extensive tracts on Earth of tropical forests, Latin America has experienced minimal interest in tropical forest management. This essay attempts to show how sustainable uses of the region's production forests is feasible, without destroying forest habitats, biodiversity and ecological functions.

Many tropical American countries still have appreciable areas of the national territory in forests. These forest-rich countries are mostly Amazonian; however, extensive forest tracts occur in the trans-Andean Chocó of Colombia and adjoining Panama, as well as in eastern Nicaragua and northern meso-America. Because the percentage of forest cover in these forest-rich countries greatly exceeds the IUCN recommended 10% in protected areas for conservation purposes (e.g., national parks and equivalent reserves), most unprotected or unreserved tropical forests

are available for development or colonization purposes. Yet traditional development in the forest-rich countries of tropical America is virtually synonymous with deforestation.

The Challenge of Sustainable Tropical Forestry—The sustainable production of timber, nontimber forest products, and ecological services (e.g., erosion control, modulating stream flow, carbon sequestration, habitat for biodiversity, and possibly recreation) is of paramount importance to the survival of the forests outside of the protected areas of tropical America. If the unprotected forests suitable for production forestry (in the broadest sense—not just for timber) are not managed under sustainable forestry principles (Gane 1992, Sharma 1992, Aplet *et al.* 1993, Ramakrishna & Woodwell 1993), these tropical forests are doomed to be cut down and converted to other uses. The principal causes of deforestation in tropical America are agricultural colonization (mostly spontaneous rather than government sponsored), extension of penetration roads, and land speculation. Logging, per se, is not a primary cause of forest loss; however, extraction tracks also often facilitate ingress by colonists or squatters. Latin American jurisprudence usually recognizes forest clearing as improving the land (i.e., higher value), as well as demonstrating tenurial rights. In countries with little forest left, there is increasing political and legislative effort to protect the remaining forests (e.g., Costa Rica, El Salvador).

The extremely limited regional experiences in tropical forest management and silviculture does not mean that the situation is hopeless. There are several exciting pilot or demonstration projects (Perl *et al.* 1991) that suggest innovative ways to manage complex tropical forests on a sustainable basis. These initiatives tend to be small scale, community-based, and diversified. The real challenges are to expand some of these efforts to a commercially significant scale, to integrate the timber industry into sustainable forestry, and to encourage the necessary funding to promote extensive production forestry based on sustainable principles. The integration of essential disciplines, such as ecology, sociology, and economics, coupled with the necessary political support, is especially critical. Key criteria for the sustainable use of tropical forests are highlighted below.

Political Criteria for Sustainable Tropical Forestry—Sustainable use of tropical forests depends on full, long-term political commitment. Most of the region's remaining forests belong to the State, hence government policies (explicit or *de facto*) determine allocation of access, use and benefits of their tropical forests. Unfortunately, the State agency responsible for the country's forest is usually weak, underfunded, and lacks adequate professional staff. Though national laws pertaining to forests are usually well-designed and comprehensive, the enforcement or implementation of regulations is often less than acceptable. The consequence is that there is little public respect, political will, or government and industry support for sustainable forestry practices.

Because the vast forested hinterland has long been viewed as the agricultural frontier, little national attention has been give to establishment of the permanent forestry estate, i.e., those forests assigned to long-term multiple-rotation production functions. The regional trend has been to demarcate protected areas for conservation objectives (e.g., national parks, wildlife sanctuaries, and biological reserves), while forest reserves are currently of lower national priority or interest. Even where a national system of forest reserves exists, government policies tend to focus on short-term exploitation (=logging) rather than long-term sustainable production of timber or other forest commodities. The unwillingness of politicians and most government forestry officials to consider or support a long-term commitment to sustainable forestry is one of the key obstacles to the survival of unprotected tropical forests.

A fundamental base for the permanent forestry estate is a national classification of land-use capability that objectively and explicitly identifies lands suitable for production forestry. Ecological sustainability should be the primary criterion in a national land-use capability classification, with social and political criteria as secondary factors. Land-use capability classification also identifies other use categories like intensive agriculture, extensive grazing, perennial crops, and protection. Forest lands classified for sustainable agriculture should not be subjected to long-term forestry practices. Long-term assignment of forest lands for production forestry is absolutely essential to the sustainable management of tropical forests.

Governments do not have a very good record of managing their forests for sustainable uses. While tropical forests can and should contribute to national development objectives, it is still customary in traditional development to sell logging rights prior to converting forest to other land uses. A selection of models for the sustainable use of their tropical forests should be tested. Decision-makers as well as foresters in tropical countries must be encouraged to actively participate in international organizations and conferences promoting the sustainable use of tropical forests.

Economic Criteria for Sustainable Tropical Forestry—Though the marketing of tropical forest products has long generated sizable profits to entrepreneurs, minuscule economic benefits ac-

crue to either the national treasury or to local people. In the former case, royalty (=stumpage) fees required of forest owners or logging concessionaires are notoriously low. In the latter, some local people earn laborer wages from logging, but local communities seldom share in the profits generated by processing and marketing of forest products.

The economic value of tropical forest commodities and services is very poorly known and seldom assessed. The real valuation of goods and services is fundamental to the survival of tropical forests. Without hard figures on the opportunity costs of forest logging, clearing, or failure to invest in management, there is little incentive to promoting sustainable forestry practices. Similarly, few entrepreneurs in the private sector have invested in the sustainable production of forest commodities, so there is not yet a great rush to follow profitable leaders.

Until tropical forest commodities are marketed in an open and free way, with prices incorporating the true environmental and replacement costs, value will continue to be lost. Measures restricting trade such as export/import bans where the resource is healthy and management systems are in place, should be minimized because they tend to lessen value of the commodity. The location of processing and manufacturing facilities should be based on economic realities, community needs and government priorities, especially with respect to the available human resources.

Industry Criteria for Sustainable Tropical Forestry—With precious few exceptions, the timber industry is very disjointed throughout the tropics. Although logs are processed and transformed into marketable products, there is virtually no feedback to forest owners or local producers. Wood may be bought and sold three to five times before reaching a consumer. This is especially true for sawnwood where the local sawmiller buys logs from a logger or trucker, then sells rough sawnwood to a finisher in a city. The greater the number of transactions, the lower the benefits to the owner of the forest, even if it be the state. Furthermore, each additional transaction tends to lessen the possibility of verifying sustainable sources of tropical wood.

Especially where forests are abundant, and even where government regulations require a forest management plan before harvesting can commence, the logging industry has been less than committed to sustainable production of timber. "Management plans" are usually no more than an operational plan for logging, with the objective of maximizing short-term returns. No attempt is made or required to minimize logging damage to the residual stand, nor is there any investment in post-logging silvicultural treatments to enhance the quality and growth of natural regeneration. The option of compensatory plantations justifying the harvesting of natural forest timber is totally unacceptable, when the purpose is to maintain natural forests.

Because of their close proximity to public opinion in consumer regions, designers, manufacturers and distributors of wood products can provide industry leadership to promote sustainable sources of tropical woods (Carbarle *et al.* 1995). Not only are some of these entrepreneurs concerned about their wood sources, but they also care about the appropriateness of the materials specified, the availability of alternative or lesser known species, the manufacturing process chosen, as well as how their wood products will be used, reused, recycled and ultimately discarded. The increasing influence of consumers on industry practices and requirements is encouraging (cf. Anonymous 1995). Though often far removed from tropical forests, direct industry involvement in sustainable forestry practices may ensure not only the continued production of tropical timbers, but also the survival of many tropical forests.

Social Criteria for Sustainable Tropical Forestry—Despite the vast extent of tropical forests in some countries, few forests are uninhabited, unused, unclaimed or uncontested. They are often the home of indigenous peoples, the traditional source of non-timber forest products (e.g., bushmeat, rubber, Brazil nuts), colonized by farmers and cattle ranchers, and logged for high-value timbers. As the forest resources are depleted, competition for or conflict over use or access to these forests usually increases. Sustainable tropical forestry can contribute to meeting local peoples' legitimate needs and expectations (Alcorn 1989, Ascher 1994).

Managers of tropical forests that provide timber or non-timber forest products must take into account local traditions, rights and dependence on the forests (Lynch & Alcorn 1994). Local people must be involved not only initially in any production system, but they should participate in the design and implementation process. Indigenous peoples have a rich tradition in sustainable forest management that should be respected (Poffenberger 1990). Local people must receive direct tangible benefits from the production activities; these should include employment opportunities, profit sharing and resource protection. The ideal system should be community-based and locally controlled.

While each community has its own distinctive resources management practices, customary laws and decision-making methods, hiring of local people as laborers may be attractive but occasionally incompatible with traditional seasonal activities. Without a commercial history or tra-

dition, local people may set priorities that include education, health and transportation. Local requests and expectations must be addressed by industry and/or government intending to commercially exploit the forest resources where these people live.

Ecological Criteria for Sustainable Tropical Forestry—Ecological criteria include bio-physical features, type of forest, and the biotic community present. The central ecological principles are the maintenance of biodiversity and ecological services. Tropical forestry systems should minimize fragmenting the forest because large blocks of contiguous forests are more effective in conserving native biodiversity, including all the animals and plants. Tropical forest management systems should explicitly include intact (=unlogged) corridors to facilitate movement of mobile animals and mitigate the effects of forest fragmentation. Tropical forestry operations should be based on ecologically sound land-use classification as well as management principles to avoid steep slopes and minimize damage to streams and riparian buffer areas. Forest soils susceptible to erosion should not be worked when saturated (i.e., rainy season) or during heavy rains.

Sustainable production systems for timber and/or non-timber forest products allow for continued ecological integrity of tropical forests (Panayotou & Ashton 1992). Uncontrolled selective logging of preferred timbers causes substantial and unnecessary damage to the residual forest. Careful layout and strict use of extraction tracks can greatly reduce damage to remaining trees. Similarly, training of personnel in marking not only the trees to be felled, but also future crop trees, and directional feeling of timber lessen logging damage to the residual forest (Dykstra & Heinrich 1992). Tropical forest management can also provide forest habitat on the periphery of a protected area.

Some Innovative Examples of Tropical Forest Management—Sustainable tropical forestry experiments and tests are increasing rapidly (cf. Anderson 1990, Perl *et al.* 1991). Only a few of these examples are mentioned here in order to illustrate the key criteria, as well as the potential for sustainable tropical forestry. (See Hartshorn 1995 for more detailed information on these examples.)

The indiscriminate felling of commercial trees, overuse of log extraction equipment (i.e., skidders, bulldozers) and extensive network of skid tracks cause an incredible amount of damage to the residual forest. Soil compaction due to frequent passage of heavy machinery inhibits drainage, often causing reduced tree growth or death. The felling and extraction of a single log may damage 10–50 other trees. Because at least a few of the damaged trees may have actual or future commercial value, industrial logging practices have a serious negative impact on the sustainability of production forestry. Recent experiments in Malaysia and Brazil to reduce logging damage show positive results. A key feature is training in directional felling so as to avoid damaging other commercial trees or pole-size individuals that could be exploited in subsequent harvests. Strict control of skidding tracks and more technical use of winching also greatly reduce damage. Computerized layout of main logging roads and all skid tracks in the Brazilian experiment increases efficiency and hence actually reduces logging costs.

Small portable sawmills, popularly known as "wokabout somils" in Papua New Guinea, enable remote villagers to process sawtimber. The indigenous Bainings communities in East New Britain use a practical forest management system that promotes excellent natural regeneration of the preferred timber species (Hartshorn 1993). Their management guidelines require that another commercial-size individual of the same species be visible within 50 m in order to harvest the focal tree. Once the focal tree is felled, they enhance the canopy opening (gap) created by felling a second and possibly third tree into the same gap. This enhanced gap allows more light to reach the forest floor, stimulating copious natural regeneration of the native shade-intolerant timber species such as *Eucalyptus deglupta* and *Pometia pinnata.*

Strip-cuts in the Peruvian Amazon produce excellent natural regeneration and growth of native trees. The strip-cut model (Hartshorn & Pariona 1993) simulates natural gaps that are necessary for establishment and growth of hundreds of native tree species. After nearly eight years, less than 10% of the tree species on the two demonstration strips were lost through competition or silviculture treatment (Hartshorn & Pariona 1993). Over the same time span so far, 141 species not present prior to logging have colonized one demonstration strip. The strip-cut model rotates four to six series of narrow (30–40 m) strips of variable length (100–400 m) in a production forest in order to maintain natural forest structure. The harvest of all trees on a strip opens up the canopy sufficiently to promote abundant seedling establishment as well as stump sprouting. The strip-cut model is also being tested in Bolivia, Costa Rica, Ecuador and Papua New Guinea.

PORTICO is a vertically integrated door manufacturing company in Costa Rica. In the mid-1980s PORTICO made a commitment to sustainable forest management by buying their own forests and implementing a forest management plan. PORTICO involves nearby landowners in the production and protection of the company's

managed forests. Their principal species is royal mahogany (*Carapa nicaraguensis*) that dominates the swamp forests of northeastern Costa Rica. By investing in considerable research PORTICO has greatly reduced logging damage, while promoting excellent regeneration and growth of royal mahogany trees. PORTICO's forestry operations have recently been certified as a sustainable source of tropical wood by Scientific Certification Systems (Seymour *et al.* 1995).

Conclusions

Tropical forests can be managed on a sustained yield basis for timber and/or non-timber forest products, while protecting biotic habitats and ecological functions, generating adequate economic returns to local communities, and providing viable models for sustainable community development. To state it succinctly, sustainable forestry must be ecologically sound, economically viable, socially responsible, and politically acceptable. If we do not come up with ways to use tropical forests without destroying these globally important resources, there is little chance that most unprotected tropical forests will survive well into the 21st century.

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